The European Foundation House: The first passive office building *renovation* in Belgium

ROGER FRANCE Jean-François[1]

[1] Architect (dip arch St Luc Brussels) MA (AA school London), main Partner at GREENARCH architecture + environment 126 rue du Ham – 1180 Brussels, Belgium – Tel +32 2 374 29 34 -www.greenarch.be - jfrf@greenarch.be - Lecturer at the Faculty of Architecture, Architectural Engineering, and Urbanism of the University Catholic of Louvain UCL – LOCI Brussels, Belgium - Rue Wafelaerts, 47/51 - B 1060 Brussels, Belgium - Tel: +32 (0)2 539 71 11 - jean-francois.rogerfrance@uclouvain.be

ABSTRACT: GREENARCH architecture + environment is designing the renovation of the European Foundation House to be the first renovated passive office building in Brussels and Belgium. Some solutions for designing the renovation such as an inner insulation in cellulose, performing glazing and external blinds—are described. The building is also taking the environment into account by the choice of green materials and use of a Smart Acoustic Passive Power ceiling system, which uses the thermal mass of the building.
Keywords: passive office building renovation, low energy, use of thermal mass, Smart Acoustic Passive Power ceiling system, sustainable building, green materials, insulation from inside, sustainable building.

THE CHALLENGE

Today, the first experiences of passive office buildings are new constructions in Brussels [1]. Creating a passive office building from scratch is more feasible than changing an existing building. The insulation placement and performance obtained are more easily done for a new building than for an existing, poorly insulated building, especially to avoid thermal bridges. Furthermore, the aim of keeping the existing building stock without demolishing and converting it to passive building is important in terms of environmental impact. The energy saved to demolish and transport, and to rebuild a new building, is not negligible in the building's Whole Life Costing and Life Cycle Assessment [2].

There is a huge potential for energy reduction by converting existing office buildings into passive office buildings. The existing office surface vacancy is estimated to be around 1.6 million square meters in 2012. This represents 12% of the office surface available in Brussels [3]. The challenge today for architects, owners, and actors in the construction sector is to convert existing buildings into energy performance constructions to meet the energy performance guidelines and reduce the consumption of buildings.

THE CONTEXT

The European Foundation House (EFH) building is located at 94 rue Royale in Brussels, just behind the Belgian Parliament. The five-level office building with 2600 m^2 will be occupied by the European Foundation Center (EFC). EFC is a nonprofit membership organization of more than 230 foundations and corporate founders. As part of the social and environmental responsibilities of the association's members, the aim is to develop an existing building as sustainably as possible. The building was designed in 1988 by architects Samyn & Partners and cladded with natural white stone with double glazing, according to the energy performances of the 1980s. The entire existing structure of the building is made of concrete. Tony Fretton architects from London made a preliminary feasibility study of the existing building in 2011.

Figure 1: Study with location of the thermal bridges in the building section.

DESIGN CONCEPT AND INSULATION

The aim of the project is to demonstrate how to transform an existing office into a passive office (15 kWh/m^2/year) with all testing and certification from the “Passive House Platform”. To achieve necessary energy reduction to reach Passive Building certification [4], the existing façade is completely insulated from the inside, and all thermal bridges are eliminated.

The study of the existing thermal bridge (Fig. 1) was done by the MatriCiel engineers with TRISCO Software, developed by Physibel [5]. The existing details plans from Samyn & Partners, as well as some investigations (to ascertain the thickness of walls and roof components) done on site are used for the simulations. The results show the need for each thermal bridge to be insulated from inside with solutions for thickness and insulation material types (Fig. 2).

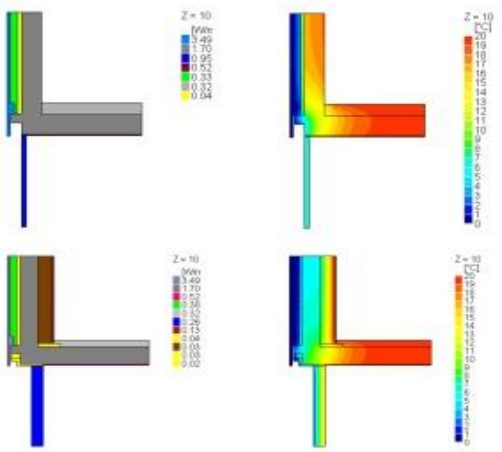

Figure 2: Simulation of one thermal bridge in the building section (junction window and slab).

The hygrothermic façade behavior and the impact of the insulation inside have also been evaluated by the WUFIpro 5.1 IBP Software, developed by Fraunhoffer Institut [6]. The insulation inside will have an impact on the reduction of the available surface by increasing the depth of the walls, the choice of the finishes inside, the thermal bridges (difficult to solve), the reduction of the use of thermal mass (by insulating the walls), and some condensation and dilatations risks. Several configurations of walls with different type of insulations were done. The results of these simulations demonstrated that the cellulose insulation should be chosen for hygroscopic, thermal, and good environmental performances.

A new vapor membrane is not necessary due to the existing façade’s composition. However, the critical issue is the air tightness. The use of the wood board against the cellulose covered by a plaster board allows obtaining a good airtightness [7].

Furthermore, the wood board allows a good resistance when the cellulose is insufflate in the 15 cm gap between the board and the existing wall (Fig. 3). A plaster board alone is not enough resistant for the insufflation of the cellulose. The economic issue is also considered with these wall and insulation components.

Figure 3: The insulation gap to be insufflated and covered by wood board and plaster board.

The junctions between panels have to be closed by a special tape for air tightness. The existing screed is also removed 30 cm away from the existing walls to allow the insulation to reach the concrete slab and reduce the thickness of the possible thermal bridge. The new insulation located 15 cm width from both sides of the existing slab (20 cm) is deleting the potential thermal bridge.

The external façade, when cleaned, is covered by a waterproof transparent paint to allow good lifetime protection of the external layer of the natural stone facade. The study also showed that the risk for corrosion of the steel rebar in the existing concrete will not be affected below 80% of the relative humidity and therefore will not be problematic in this case.

LIGHTING AND OVERHEATING

By insulating the whole inner envelope of the building, heating demand is reduced, but the risks of overheating are increased due to external solar heat gains, especially in summer. Strategies such as limiting the external solar impact are created by placing external automated blinds (see Fig. 4) and performing glazing. Refreshing strategies are also taking place inside the building.

The new exteriors blinds will be light grey and not fully vertical but in a projecting shape, allowing a view to outside while the blind is closed. This will avoid the blinds closed/lights on syndrome [8]. The lighting has been studied with MatriCiel engineering. The artificial lighting is dimmable according to the level of natural light on the table. All artificial lights are low energy consumption and integrated in the ceiling system.

Figure 4: The façade with the external solar blinds.

THERMAL DYNAMIC SIMULATIONS

The aim of making thermal dynamic simulations before doing the project renovation is to evaluate the thermal behavior of the building during the limited period studied. These dynamic simulations were done by the MatriCiel engineers with Trnsys 17, developed by the Solar Energy Laboratory (SEL) of the Winsconsin University.

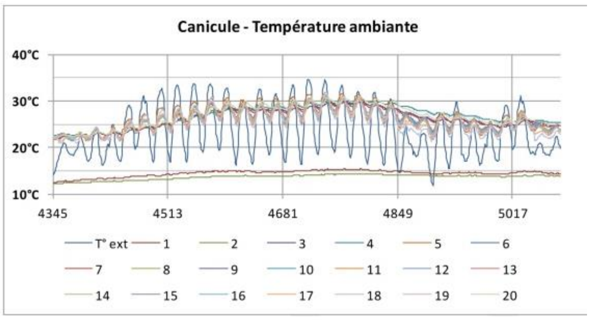

Figure 5: Simulation of the temperature inside the building with night cooling.

The simulations [9] take into account the integration of the air, walls, humidity temperatures, with weather and occupation conditions in different periods. The building is divided in different areas. The aim is to consider each area as homogeneous in terms of temperature and humidity but also with orientation, activity, and internal gains. The simulation results should be interpreted as general orientation of the realistic results, depending on the hypothesis and the period considered. The aim is to help the design and the future management of the building comfort.

This will also help to evaluate the heating and cooling needs of the building with different parameters such as:

- Level of insulation (existing, before double glazing and triple glazing);
- Use or not of external blinds;
- The level of the air tightness n50: 4.5, 1.5 or 0.6 h-1;
- The hygenic ventilation level: extraction from WC, simple or dubble flux with heat recuperation;
- The use or not of night and day intense ventilation cooling;
- The need or not for an active cooling system.

The results are showing that the use of external blinds allows reduction of the need of cooling close to zero. The inner thermal insulation with the double glazing replacement (triple in the ground and first floors due to the large glazing surfaces) is totally obvious. A comfortable temperature will be reached even during very hot summer periods (Fig. 5).

The energy savings are also significant thanks to the insulation and the reduction of thermal bridges. The main challenge once again is to obtain the airtightness with the renovation of existing façade to reach the passive building standards (n50 = 0.6 h-1) [4]. During the work beginning in May 2013, a blower test has been done in a small area of the building to test the airtightness of the renovated façade before the placement of the insulation (Fig. 6). This test shows that the existing façade fortunately has acceptable air tightness due to the existing concrete structure. The connections with window frames have to be carefully closed and sealed to avoid air infiltration.

Figure 6: Blower test door during the site installation.

THERMAL MASS AND CEILING SYSTEM

The use of thermal mass is also a key issue: The Smart Acoustic Passive Power (SAPP) ceiling system is placed and allows for a cooled ceiling system with the use of the existing concrete slab, which is visible and thermally accessible. A whole climatic concept was recently created by the Belgian company Interalu with a CO_2-free production process [10].

The system is designed for buildings that conceptually strive for the highest durability and ecological standards with flexibility preservation and thermal as acoustic comfort. The basic principle of this ceiling is classic: Water flows through pipelines in the ceiling, thus bringing the space to the desired temperature (Fig. 7).

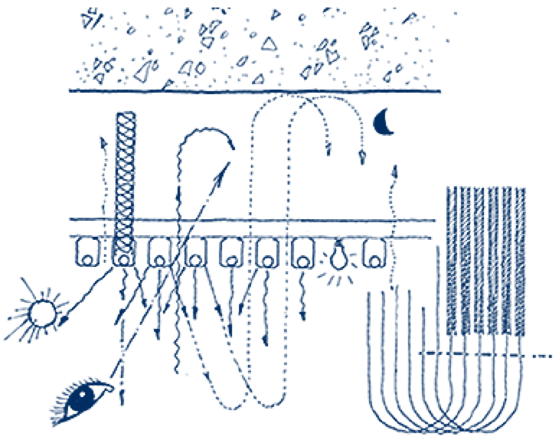

Figure 7: The Smart Acoustic Passive Power (SAPP) ceiling system from Interalu.

The open structure (40% in continuous to 70% in island applications) makes the SAPP ceiling unique. It allows the mass of the building to integrate in the ecological energy concept of the project through night cooling. The open structure also allows convection, which makes the ceiling system very efficient. It is comfort Class A with a supply of 18 to 20 °C (Fig. 8.). The system cools and heats up only when needed, and can make maximum use of heat pumps.

Figure 8: Cooling from the ceiling system (Interalu) and the use of thermal mass.

Finally, the open structure creates the necessary space for vertical acoustic baffles. Therefore, there is no air conditioning, and ventilation is reduced to a minimum.

HEATING AND COOLING PRODUCTION

The heating and cooling productions of the building have also been studied by Marticiel. After simulations [11], the conclusion is to have a system with a reversible heat pump “air-water” linked with a condensate gas heating system. This is the most interesting solution in energy and environmental (CO_2 emission) issues.

The consumption of the building for the heating and cooling system is evaluated to be around 8 T of CO_2 emissions only per year (compared to 57 T of CO_2 emissions per year for the building before renovation).

GREEN MATERIALS AND RECYCLING

Furthermore, as an example of sustainability, the building is developed with a view to think globally on environmental issues.

The materials are carefully chosen to reduce the environmental impact of the building. The design systematically gives preference to solutions with a minimal ecological impact and a long life duration time. During the renovation work, a recycling treatment system of raw materials from the site is placed, imposed to the contractor. The construction elements placed allow replacing and dismantling without breaking all components.

The SAPP ceiling is designed and built in Belgium to reduce the embodied energy of this important material need. The distances between raw material and installation are restricted to the absolute minimum. All materials are perfectly recyclable.

The choices of materials for the finishes are also environmental friendly. The carpet is made from 100% recycled materials, and even the furniture is made in labelled wood. The painting is water based without VOCs. The plaster boards and the cellulose insulation also have a cradle-to-cradle label certificate.

BATEX AND ACCESSIBILITY

In January 2013, the Brussels Region was awarded the renovation BATEX (*batiment exemplaire*) status as the first passive renovated office building in Brussels. This award and subsidies are given by the Brussels Region to promote environmentally friendly building by making exemplary sustainable buildings [1].

The BATEX grant covers about 7% of the total cost, which is about half the extra cost involved in obtaining a passive building compared to a "normal" refurbishment project.

Accessibility for disabled people is also taken into account in the project. The change of lifts and sanitary facilities are all disabled friendly on each level. Bikes parking and shower are also available in the building.

CONCLUSION

The renovation of an existing office from the 1980s into a passive office building is possible today. There is a huge potential for energy reduction by converting existing office buildings into passive office buildings.

This refurbishment example of an existing building shows clearly that possible solutions can be found to participate in every scale toward a more sustainable architecture for a renewable future.

Figure 9: The building during the renovation in April 2013

Figure 10: The building with the inner insulation in progress

ACKNOWLEDGEMENTS – CREDITS

The author would like to thanks all participants of this project.
Owner: European Foundation House
Occupant: European Foundation Center, www.efc.be
Architects: GREENARCH architecture, www.greenarch.be
M&E environment engineer: Matriciel, www.matriciel.be
Structural engineer: Bureau Delvaux, www.iradelvaux.be
Building contractor: Valens, www.valens.eu
The building works started early December 2012 and will be completed by the end of August 2013.

REFERENCES

1. Deprez B., Cech J., IBGE, (2012). A Bruxelles les bâtiments exemplaires se racontent. Editions Racines. ISBN 9782873867980. pp. 26–32.
2. Roger France, J. F., (2002). Whole Life Costing (WLC): a common design methodology for building projects in Europe. Design with the environment. Proceedings of PLEA 2002, Toulouse, France. Edited by GRECO and ACAD. pp. 645–649
3. Pineau, C., (2012). European Office Market 2012. BNPPARIBAS Real Estate. p. 22.
4. International Passive House Association. Available: http://www.passivehouse-international.org [10 05 2013].
5. Nobels, M. A, Mulliez, R. [Internal document]. Etudes relative aux ponts thermiques. MatriCiel [26 June 2012].
6. Nobels M. A, Leclercq, T. [Internal document]. Comportement hygrothermique de la facade et impact d'une isolation par l'intérieur. MatriCiel [26 June 2012].
7. Image from GREENARCH showing the composition of the inner insulation complex against the existing facade.
8. Bordass, B., (1995). *Architect Journal*, 202(3): p. 37.
9. Nobels, M. A, Da Conceicao, N. [Internal document]. 1176 H Simulations thermiques Dynamiques. MatriCiel [7 March 2012].
10. Interalu SAPP, (2013). Available: http://www.sapp-ceiling.be
11. Nobels, M. A. [Internal document]. Comparaison des systèmes de chauffage et de refroidissement pour la rénovation du bâtiment EFH, MatriCiel [16 April 2012].